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This study was concerned with the effects of selected experiences on the ability of preschool children to use conservation of length and conservation of length relations. The experiences involved the equivalence relation "the same length as" and the two order relations "shorter than" and "longer than." The subjects were 51 four and five year old children in the Suder Elementary School, Jonesboro, Georgia. Students' verbal maturity, intelligence, and social class ranges were measured by the Peabody Picture Vocabulary Test, Stanford Binet Intelligence Scale, Form L-M, and the Hollingshead Two Factor Index of Social Position, respectively. All children received instruction in establishing length relations between two curves, conserving length relations, and conserving length. The conclusions drawn from an 18 item conservation of length relations test support Piaget's Theory that experience is necessary, but not sufficient for the development of logical thought. The data suggest that the ability to use the reflexive property is different from and precedes the ability to use the non-reflexive property. Finally, there appears to be little, if any, relation between the student variables, Verbal Maturity, I.Q., Age, and Social Class, and scores earned by four and five year old children on conservation of length items involving the reflexive or non-reflexive property. (RP)

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AN ANALYSIS OF THE EFFECTS OF SELECTED EXPERIENCES ON THE ABILITY OF PRESCHOOL CHILDREN TO USE CONSERVATION OF LENGTH AND CONSERVATION OF LENGTH RELATIONS

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INTRODUCTION

A number of studies have been conducted on the ability of young children to conserve length relations. In a study by Lovell, five and six year old children were asked if two rods were still of the same length after one rod had been transformed. Lovell found that the majority of the five and six year old children judged the rod that was moved to be the longer (3).

Smedslund, in a study conducted to determine interrelations of specific acquisitions of ability for concrete reasoning, observed that of 63 children between the age of 4 years, 3 months, and 7 years, 0 months (inclusive), 22 children passed a conservation of length item. Of 38 children between the ages of 4-3 and 6-0 (inclusive) only seven passed (6).

Beilen studied the effects of selected experiences on the ability of young children to perform certain Piagetian tasks. One problem of interest to Beilen was the limits upon the acquisition of measurement operations associated with age when a deliberate effort is made to foster their acquisition through instruction. The aim was to generate generalizations necessary to measurement such as conservation. He concluded that selected experiences did contribute to first graders' acquisition of concepts in length measurement (1).

Piaget concedes that experience is a basic factor (but not sufficient) in the development of cognitive structures. The two reasons he cites for this view are (1) conservation of substance is a logical necessity and not a function of experiences and (2) physical experiences and logical-mathematical experiences are psychologically very different. A physical experience is merely knowledge gained about the objects by an abstraction from the objects. Logical-mathematical experiences are much more profound and are characterized by knowledge from action effected upon the objects, which is quite different from a physical experience (5, pp. 11-12).

Several characteristics of the nature of experiences for young children to develop logical-mathematical structures have been identified by Piaget. Some of the factors are as follows:

(1) The experiences should involve simple, elementary, logical structures.

(2) There should be a coordination of actions supported by concrete materials.

(3) Language should not be used to introduce an idea, but should serve only to translate what is already understood (5, pp. 5, 12,16).

Another aspect of the experiences that should be considered is the quantitative vs. qualitative nature of the experiences. For example, should the experience involve a subdivision of a metrical system or should objects in their entirety be compared? There is evidence that a time lag exists between a child's ability to use qualitative operations and those which are truly metrical (4).

It is apparent that learning experiences should not be presented to the preschool child by the use of words alone. The experiences should be qualitative rather than quantitative in nature. Operational definitions involving physical operations with concrete objects must be included. Eventually, the physical operation should be performed by the child himself. Central to Piaget's Theory is the fact that the child is active.

This study is concerned with the effects of selected experiences on the ability of preschool children to use conservation of length and conservation of length relations. The experiences involved the equivalence relation "the same length as" and the two order relations "shorter than" and "longer than." These relations are more elementary and logically precede measurement. Operationally, on a basis that does not assume number, for a child to find any one of these relations between two "rods," he will place the "rods" side by side and align two of the endpoints. The relative extension of the two remaining endpoints then

determines the relation for the child. During this operation the child's attention is focused on particular percepts.

Several properties hold for the relations "the same length as," "longer than," and "shorter than." In this study, the properties of concern for the relation "the same length as" are the reflexive (A~A) and symmetric (If A~B then B~A) properties. For the relations "longer than" or "shorter than," the properties of concern are the non-reflexive (A≁A) and asymmetric (If A~B then B≁A) properties.

The following statements are all logical consequences of these relations.

(a) A shorter (longer) than B is equivalent to B longer (shorter) than A.

(b) A the same length as B implies A is not shorter (longer) than B.

(c) A shorter (longer) than B implies A is not longer (shorter) than B.

Conservation of length is viewed as a test of the reflexive and non-reflexive properties. Conservation of length relations involves a test of the symmetric property and asymmetric property or the logical consequences of a relation.

Basic Questions

The following questions are of basic concern in the study.

1. (a) If children are able to establish a length relation between two curves, are they able to conserve that relation without formal experiences?

   (b) If children are able to establish a length relation between two curves, are they able to conserve the relation involving properties or logical consequences of that relation without formal experiences?

2. (a) What is the effect of selected experiences on the ability of children to conserve length relations?

   (b) What is the effect of selected experiences on the ability of children to conserve length relations involving properties or logical consequences of length relations?

3. Are children able to conserve length without formal experiences?
4. What is the effect of selected experiences on the ability of children to conserve length?
5. What is the relationship between certain student characteristics?

PROCEDURE

The subjects were 18 four year old children and 33 five year old children in the Suder Elementary School, Jonesboro, Georgia. At the initiation of the study, the range of ages was 47-57 months for the group considered as four year olds and 59-69 months for the group considered as five year olds. The children were in three self-contained classrooms with fours and fives in each room.

The verbal maturity range measured by the Peabody Picture Vocabulary test was 83-119 for the four year olds and 55-120 for the five year olds. The intelligence range of the subjects as measured by the Stanford Binet Intelligence Scale, Form L-M, is 98-145 for the four year olds and 81-130 for the five year olds. According to the Hollingshead Two Factor Index of Social Position, the social classes of the subjects range from I (high) to V.

All children received instruction in establishing length relations between two curves, conserving length relations, and conserving length. Small group instructional procedures were utilized in each room. An instructional group generally consisted of six children. Conservation of Length and Conservation of Length

Relations Tests were administered after the Length Comparison Instructional Unit and after the Conservation Units. The children were treated on a one-to-one basis for evaluation. The tests were administered by specially trained experimenters.

The Conservation of Length Test consisted of six items. Three of the items involved the reflexive property of the "same length as" and three of the items involved the non-reflexive property of "longer than" or "shorter than". Five different material sets were employed. The responses obtained from the children were "yes" - "no" responses. In order to score the item involving the reflexive property correctly, a child had to respond "yes"; and in order to score those items involving the non-reflexive property correctly, a child had to respond "no". The items were randomized independently for each child.

The Conservation of Length Relations Test consisted of eighteen items. Nine of the items were constructed to measure conservation of length relations without involving any properties or consequences of the relations. These items were constructed in such a way that a child had to first establish a relation between two curves and then conserve that relation. The question was worded in such a way that the terms of the relation were not interchanged and the relation was not changed (e.g., if the child established the relation A~B, then either A or B was transforme and the question asked was "Is A still the same length as B?") Each of these nine questions required a "yes" response.

The remaining nine items involved the asymmetric property or consequences of the relations. Four of the nine items involved the asymmetric property and five of the items involved a change of the relation. The item format was the same as that outlined immediately above, but with a different question. The same material sets were used in each set of nine items. The eighteen items were randomly assigned for each child.

Definitions of the pupil abilities involved in the evaluation process are as follows:

(1) Conservation of length of a curve (Reflexive or non-reflexive properties):

Given a curve A and a length preserving transformation T, a child is said to be able to conserve the length of A if and only if he deduces that A and T(A) are of the same length or A and T(A) are not of different lengths.

(2) Conservation of a length relation between two curves:

A length relation between two curves A and B is conserved by a child if and only if the relation is (a) established by the child and then (b) retained, regardless of any length-preserving transformation on one or both of the curves.

Experimental Design

The nine items of the Conservation of Length Relations Test for which a response of "yes" was correct are considered to exemplify a Level I. The nine items for which a "no" response was correct are considered to exemplify a Level II.

If one considers the nine items written at Level I or Level II, regardless of the nine items written at the other level, a probability of .02 exists that a child can respond correctly to eight or nine items if he is guessing. One cannot, however, with any degree of confidence, assert that in fact the child did not possess a response bias unless the remaining nine items are considered. Based on guessing, the probability of at most one correct response on the other nine items is .02. For a child to be classified as just Level I or Level II, he/she must respond correctly to eight or nine items of the level in question and no less than two items of the other level. The number of children who met criterion for Level I or Level II was investigated.

The probability of a child obtaining at least six correct "yes" responses and six correct "no" responses is no greater than .06. For a child to be

classified at Level I and II, he/she must have at least six of the nine items which were written to exemplify Level I and six of the nine items which were written to exemplify Level II correct. The proportion of children who met criterion on Level I and II was investigated.

For a child to possess the ability to conserve length, the performance criterion of a total score of five or six was established. The probability of the event "at least five or six correct responses" is approximately .11. It must be pointed out, however, that children do respond on the basis of perceptual cues, so that the actual probability of a child obtaining a five or six, given that he does not possess the ability to conserve length, may be much lower than .11.

In order to check the hypothesis that the distribution of total scores on each test is not different than a theoretical distribution based on random responses, a goodness of fit test was employed. The McNemar test for significance of changes was utilized to determine the affect of selected experiences on the ability of the children to conserve length and length relations.

To answer the question of the relationship between certain pupil characteristics and earned scores, correlation studies were conducted as well as observational studies.

Results

The Conservation of Length Relations Test reliabilities range of .81 to .88 is substantial. Also, supporting interpretation of the data are two identifiable factors on the posttest. Each item at Level II had a loading greater than .5 on Factor I. The second factor clearly involves those items written at Level I. Factor I may be named "Conservation of Length Relations: Level II," and Factor II may be named "Conservation of Length Relations: Level I."

After experiences in length comparisons, three four year olds and three five year olds met the criterion for Conservation of Length Relations: Level I and II. Five four year olds and fourteen five year olds met the criterion after selected experiences in conservation. According to the McNemar test, the change for the five year olds that met performance criterion for Level I and II from the pre to post tests is significant which indicates that the probability that any five year old child changed from non-conservation to conservation is greater than the probability he would change from conservation to non-conservation. The probability of a four year old child gaining Conservation of Length Relations: Level I and II was not statistically different from the probability of losing it.

Ten four and five year old children were classified at only Level I on the posttest. This is a total change of four over the pretest. No child met criterion for only Level II on the posttest.

The actual frequency distribution of scores for each age group by conservation level did statistically depart from a theoretical distribution at the .005 level.

The correlations between the earned Level I and Level II total scores with Verbal Maturity scores, Age, and Social Class were not significantly different than zero. The only significant correlation was between I.Q. and the posttest Level II total scores. This correlation of .34 was low.

The reliabilities of .43 and .53 for the Conservation of Length test are low. A contribution to the low test reliabilities is the existence of more than one factor in the test. The items loaded on the two factors identified as the reflexive and non-reflexive properties.

One four and one five year old earned a score of five or six on the Conservation of Length pretest. The number of four and five year olds meeting the

criterion on the posttest increased to six and nine respectively. The two children meeting the pretest criterion did not meet the required level of performance on the posttest. However, the proportion of students who changed from non-criterion to criterion is significantly greater than the proportion of children who changed from criterion to non-criterion. There was also an increase from pre to post test in the number of children that responded correctly to all the reflexive items but did not meet the criterion. The change was from seven to twenty-one.

The theoretical and actual frequency distributions of scores earned by the five year olds on the pretest and posttest satistically depart at the .005 level. It was also found that the frequency distributions earned by the four year olds statistically depart at the .005 level from the binomial distribution.

All correlations of the pre and post test total scores with the variables (1) Verbal Maturity, (2) I.Q., (3) Age, and (4) Social Class were low. However, the correlations between total scores and Social Class were significantly different than zero.

Conclusions and Discussion

Level I items were constructed to measure the extent to which the children realize that the length relation they established between two curves is independent of the proximity of the curves. Before administration of the Conservation Units, only about 12 percent of the children could be categorized at Level I. After the administration of the Conservation Units, however, the evidence indicated that about 57 percent of the children could be categorized at that level. At the same two points in time, the percentages were eight and 37 with regard to Level I and II, which was a statistically significant change. It must be emphasized that the children in this 37 percent not only were able to establish a relation between two curves and retain the relation regardless of the proximity of

the curves but were able to use the asymmetric property and logical consequences of the relations under consideration. It is certainly true that the experiences contained in Conservation Units did not readily increase the children's ability to use logical consequences of the relation they were able to establish.

The data suggest that the mean I.Q. for the five year old children who met criterion for Level I and II is greater than the mean I.Q. for those who did not meet criterion. The correlation of total scores for Level I and II with the variables of Verbal Maturity, I.Q., Age and Social Class are not significant with the possible exception of a low correlation between I.Q. and Level II posttest scores.

Very few four and five year old children are able to conserve length prior to formal experiences in conservation of length. Conservation of length referred to here involves both the reflexive property of "the same length as" and non-reflexive property of "longer than" or "shorter than." Elkind (2) apparently would classify this type of conservation as conservation of identity even though he did not subdivide conservation of identity with regard to the reflexive and non-reflexive properties. An effort is made to not confuse conservation of length with conservation of length relations which Elkind refers to as conservation of equivalence.

Some four and five year old children have the ability to conserve length involving the reflexive property but not the non-reflexive property. Informal experiences appear to be sufficient for these children to exhibit this type of conservation of length. Before formal experiences, 14 percent of the sample used conservation of length involving the reflexive property compared to four percent who conserved length using both properties.

Selected experiences significantly increase the ability of four and five year old children to conserve length involving both properties. After the formal

experiences, 41 percent of the sample conserved length involving only the reflexive property, and 30 percent of the sample conserved length involving both. Only 29 percent of the sample did not have the ability to conserve length involving the reflexive or non-reflexive properties.

The above conclusions substantiate Piaget's Theory that experience is necessary but not sufficient for the development of logical thought since all the children received the same selected experiences.

The data suggest that the ability to use the reflexive property is different from and precedes the ability to use the non-reflexive property. It appears that reflexive situations are not sufficient to determine a child's ability to use conservation of length. Conservation of length is not unitary in nature relative to the reflexive and non-reflexive properties.

There appears to be little, if any, relation between the student variables Verbal Maturity, I.Q., Age, and Social Class and scores earned by four and five year old children on conservation of length items involving the reflexive or non-reflexive property. Only correlations involving Social Class were significantly different than zero, but these correlations were low. These variables seem to have very little affect on the ability of four and five year olds to benefit from formal or informal experiences in conserving length.

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